REPORT OF THE SEVENTH MEETING OF THE ILC PROJECT ADVISORY COMMITTEE (PAC)

14/15 November 2011; Institute of Physics, Academy of Sciences of the Czech Republic, Prague, Czech Republic

Committee: Jia-Er Chen, Beijing; Lyn Evans, CERN (Chair); Enrique Fernandez, Barcelona; Stuart Henderson, Fermilab; Robert Orr, Toronto; Roy Rubinstein, Fermilab (Secretary); John Seeman, SLAC; Hans Weise, DESY

Apologies: Jon Bagger, Johns Hopkins; Katsunobu Oide, KEK; Raj Pillay, TIFR

1. Introduction

The ILC Project Advisory Committee (PAC) was formed in 2008 to assist the International Linear Collider Steering Committee (ILCSC) in the ILCSC's oversight of the ILC accelerator and detector designs. The PAC mandate is given in Appendix I.

The seventh meeting of the PAC took place on 14/15 November 2011 at the Institute of Physics, Academy of Sciences of the Czech Republic, Prague, Czech Republic. The PAC was very grateful to its hosts at the Institute for their excellent hospitality which made this meeting possible, productive, and enjoyable. The meeting consisted of two days of presentations on the ILC detector status and plans and on the status and plans for the ILC accelerator. The PAC thanked the leadership and the presenters of the ILC detector and accelerator organizations for all of their efforts which allowed this evaluation of their activities. The meeting agenda is given in Appendix II, and the presentations to the Committee are in Appendix III. In addition, opening presentations by Petr Reimer on the status of particle physics in the Czech Republic, and by Jaroslav Cvach on ILC detector R&D at Czech institutions, were of considerable interest to the Committee.

2. Detector Reports

A. Research Director Sakue Yamada said that the Detailed Baseline Design (DBD) Report would be available at the end of 2012; the interim report is almost complete, and Yamada listed the content titles. He then discussed the status of the two detector groups. Both groups are preparing for physics simulations with the new benchmarks. The DBD will demonstrate that the detectors will have the capability to meet the ILC physics goals. The CLIC push-pull team has joined the ILC push-pull effort. The ILC groups have contributed to the CLIC CDR, and this will

be reciprocated. The SB2009 working group is coordinating the discussions on 1 TeV parameters with the GDE.

Yamada reported that IDAG has been very helpful to the RD organization in its twice a year monitoring of detector activities and those of the Common Task Groups. A working group has been developing a common costing method for the two collaborations, and a first update of costs will be made by February 2012. Yamada gave a brief description of activities of each of the Common Task Groups.

The detector community appreciates ILCSC activities to define the post-2012 situation, reported Yamada. He noted that in a new post-2012 governance scheme, it may be better to separate the current dual roles of WWS co-chair and RD regional contact which has been helpful during the R&D phase. He wondered what should be the tasks of a post-2012 advisory group like IDAG, and felt that something similar to the Common Task Groups would be needed post-2012. As at present, funding---for the detector groups and for common activities like IDAG travel---will be an important issue after 2012.

Yamada's presentation is given in Attachment I

B. Jim Brau reported on the physics and detector study for 1 TeV (Attachment II). He noted that the 2006 parameters allow the collection of ~ 1 ab^{-1} in about 3-4 years at 1 TeV. Three reactions have been studied:

e+e- -> neutrino neutrino H
e+e- -> ttH
e+e- -> W+W- with polarized beams

The constraint of 300MW site power has been imposed, and up to now 5% and 10% beamstrahlung has been studied. These will be used in the DBD simulations

C. The report on IDAG was given by Michel Davier. He said that IDAG will give comments and advice to the RD on the DBD drafts. There has been good progress on subdetector R&D for the two detectors, and good progress on push-pull activities; funding and technical manpower shortages are still an issue, particularly so for SiD. Some detector R&D will be incomplete by the DBD, and will need to continue past that date. A common costing working group of the two collaborations has been set up. The increasing collaboration between the ILC detector groups and those of CLIC is a very positive development. Very valuable work has been done to identify key processes for physics benchmarking at 1TeV. The recent document describing spin-offs from ILC detector R&D gives a good case for continuing these studies. ILD is still carrying forward several subdetector options, which causes more work for the collaboration; SiD is more focused.

Davier's presentation is in Attachment III.

D. Jan Timmermans described the ILD status and its related test beam activities (Attachment IV). He felt that keeping several subdetector options at this stage was valuable, as it ensured a broader participation. Three subdetectors with options have agreed to a common reconstruction

method, and only the HCAL options have yet to reach that stage. Timmermans said that ILD will meet the DBD requirements; he noted the need for additional personnel, especially in the area of engineering support. In the costing area, the collaboration is focusing on the cost drivers. The hardware baseline will be frozen in late Spring 2012

E. The status of SiD was given by Philip Burrows. He listed the items expected to be included in the DBD. He noted the close collaboration with CLIC, including work on 3 TeV SiD tracking studies. Burrows then gave the status of each of the SiD subsystems, and said that the DBD would contain a full simulation of a realistic detector design as well as results for the 1 TeV benchmarks and for e+e- -> tau tau at 500 GeV. Cost estimates will be given by subsystems and by parameters such as HCAL thickness.

Burrows' presentation is in Attachment V.

3. **MDI Report**

Karsten Buesser noted the fruitful collaboration on MDI between the Detector MDI group, the GDE BDS and CFS groups, the ILD and SiD collaborations, and also the close links with CLIC. A boundary condition is that the changeover between the two experiments should only take a few days. A major milestone was reached with the agreement on a platform-based detector system for both collaborations; whether to use air pads or rollers for detector movement is still under study. There is some concern over whether detector movement could affect the close-by damping rings. CFS studies of the interaction region have been launched with a contractor. Buesser showed the most recent experimental hall layout, which is based on the CMS assembly method of lowering large pieces of the detectors into the hall. He also showed a possible layout for a hilly site, where the access to the IR is horizontal, not vertical.

The QD0 final focus magnet (which contains quadrupole, sextupole, octupole coils and many correction coils) is under design at BNL.

Buesser's presentation is given in Attachment VI.

4. **Accelerator Reports**

A. Marc Ross gave the report on SCRF R&D (Attachment VII). There are 2 baseline high level RF options: Klystron Cluster and Distributed RF System (DRFS); the system given in the RDR is now a backup. The R&D goal is 35 MV/m with 90% yield, with gradient spread under +-20%. There should be ~ 3% cavity vertical test to cryomodule degradation, and ~7 % operational overhead, giving an operating average of 31.5 MV/m. Ross listed the remaining baseline choices, and raised the question of what fraction of cavities should be cold tested.

Ross discussed the remaining baseline choices for the TDR, and the linac system goals and achieved in tests at FLASH, KEK, Fermilab and the XFEL. He gave the R&D priorities for

2012, and then the plans for NML and STF up to ~ 2015. For 1TeV, "strawman" parameters are 45 MV/m and Q0 of 2x10**10; new technology will be needed for this.

Ross then described the results from the S1 Global test, including the information available on tuner failures. He also gave reasons for future studies on field emission. In answer to a question, he said that tumbling seems to work well for improving cavity gradient if the cavity is reasonably good to begin with.

B. Preparations for SCRF industrialization were presented by Akira Yamamoto. He said that industry would build cavities to print, and its role would end before the vertical tests; labs would be responsible for cavity performance. He then showed the different roles of industry, industry/lab, hub lab, and ILC host lab. Yamamoto said that companies must be given clear information, specifying the cavity deliverable; plug compatible interfaces need to be established.

The visits to, and communication with, potential industrial companies (16 so far) was almost completed in 2011, and there has been a study of specific topics (such as system engineering for mass production), and a mass production technology study has been prepared. Companies have been asked to consider production of 20, 50 and 100% of the cavities, in 3 or 6 years, after 2 years of preparation. Yamamoto then gave some current updated cost figures, with comparisons where possible with RDR numbers and those of XFEL. He said that cost estimate work for the TDR should be completed by April 2012.

Yamamoto's presentation is in Attachment VIII.

C. Barry Barish gave the GDE report (Attachment IX). He said that guidance is needed on what system tests should be carried out before construction. Cavity yield reached 50% at the required gradient in 2010, with an expected improvement to 90% by the TDR. Spreads of +-20% will be allowed in the 35 MV/m cavity vertical test gradient and the 31.5 MV/m operational gradient. Tests using ATF2 have been delayed by the earthquake. CesrTA studies have led to an electron cloud mitigation plan for each accelerator element. So far, design changes have led to ~ 7-10% cost reductions from the RDR. Barish described the 2 projected volumes of the TDR.

The TDR cost estimate will be for 500 GeV, for an 8 year construction period. Not included will be R&D prior to construction, pre-operation costs, etc. An approximate cost of a 1 TeV upgrade will be provided separately. Barish noted that exchange rates have changed since the RDR cost estimate, and escalation rates have differed for different countries. The GDE is starting to look at how to upgrade to 1 TeV. A limit has been set on incoming power use of 300 MW; the assumption so far is that future developments will lead to cavity gradients of 45 MV/m and a Q0 of 2x10**10. Barish commented on the two candidate sites in Japan and their features; local communities there have organized geological surveys.

Barish noted that the GDE will have completed its mandate by 2012 to mid-2013; GDE has given its ideas to ILCSC on what is needed for the succeeding 3-5 year period. In particular, system tests need to be defined. In answer to a question, he said that an important future need is for engineering drawings to be made; this gives input to value engineering, but is difficult to obtain for a non-approved project.

In the discussion following Barish's presentation, there was strong support for the need for accelerator system tests following the TDR and prior to the beginning of construction.

D. Toshiaki Tauchi reported on the ATF2 status, where the goal is to verify the ILC final focus optics and nanometer stability. He described the beamline design, and said that the local chromatic correction in ATF2 is superior to non-local (as used, for example, in FFTB); ATF2 has the same number of magnets as the ILC final focus. Tauchi described the equipment displacements caused by the earthquake, and the recovery history since. The recovery has been going well, with operation resumption in October 2011, and Tauchi showed a draft schedule. His presentation is in Attachment X.

E. The status of GDE Project Implementation Planning was given by Ewan Paterson (Attachment XI). GDE has looked at the governance models of several large science organizations (ALMA, ESS, FAIR, ITER, SKA, XFEL and CERN), and recommends that ILC have a treaty organization similar to ITER. On funding models, the likely situation is a host providing ~50% (partially offset by the economic benefits to the region) and several partners (nations or groups of nations) providing ~10% each. Operating costs would be shared by the partners, and not be charged to users; the host site has the responsibility for decommissioning.

Paterson noted that an ILCSC subcommittee will consider ILC site selection issues, although GDE would be responsible for technical criteria. In-kind contributions are expected to be a major method of funding, although an adequate common fund (>10%, and which is not to be considered contingency) is essential. There should be central control of the total funding. The host will be responsible for civil construction and conventional facilities. Manpower can be considered an in-kind contribution.

Paterson gave an 8 year construction schedule example; this would have horizontal tunnels complete in year 4, and detector completion at accelerator turn on for commissioning in year 7.

In answer to questions, Paterson said that a strong central organization, with an adequate common fund could avoid some of the problems experienced in the ITER project.

F. Nick Walker reported on the TDR plans and scope. The TDR will be completed by the end of 2012, with formal publication in early 2013. Part 1 (~250 pages) will describe the R&D carried out to support the baseline design; the baseline design will be in Part 2 (~300 pages). In addition, there will be an Executive Summary (~50 pages) and an outreach document (~25 pages). The DBD report and the physics document will be produced at the same time as the TDR. Walker gave the schedule to produce the documents by the end of 2012, noting that it was very aggressive. He also listed the people responsible for the production.

Walker's presentation is in Attachment XII.

G. The cost estimate for the TDR was discussed by Gerry Dugan (Attachment XIII). He noted that what will be produced is a "Value Estimate", where value is defined as the lowest

reasonable estimate of the procurement cost for the appropriate quantity. “In-house Labor” is at the ILC lab or at collaborating institutions. Costs will be for 500 GeV, for an 8 year construction period; pre-engineering, R&D prior to construction, and some other non-construction costs are not included. An approximate cost for a 1TeV upgrade will be given separately. The cost estimate for an item should be the lowest world-wide vendor cost meeting specification and quantity, consistent with the project schedule; it includes all tooling, testing, etc. Escalation over the construction period and contingency are not included. The cost will correspond to 50% probability on the cost distribution curve.

Dugan said that costing will use Purchasing Power Parity (PPP) as defined by OECD; this shows the ratio of prices in national currencies for the same item in different countries. A well-known example is the “Big Mac index”. Dugan gave his view of the advantages of PPP over using currency exchange rates; it also has advantages when considering in-kind contributions. He also gave examples of transferring RDR costs to 2011 PPP costs if the ILC were totally built in each of the 3 regions. He gave estimates of when in 2012 final cost estimates should be available.

Among outstanding concerns, Dugan mentioned the lower cost of cavity/cryomodule production by 1 provider compared to distributed production, and how to compare CFS costs in different regions because of different approaches to civil construction in the different regions.

4. **Reports on ILC-CLIC Collaboration**

A. Physics and Detectors

Juan Fuster said that there are now two CLIC detector concepts, CLIC_SiD and CLIC_ILD, based on the corresponding ILC detectors; tracking and ECAL are unchanged between the ILC and CLIC versions. There is cooperation on the CLIC CDR (2011) and the ILC DBD (2012), in addition to cooperation on software, electronics, HCAL and other items. Work so far has shown that physics can be successfully accomplished with a multi-TeV CLIC.

Fuster noted that the major linear collider workshops (Geneva in 2010 and Granada in 2011), are now joint ILC-CLIC, with joint organizing committees, etc. Discussions are taking place on CLIC representation on the WWS International Organizing Committee.

Fuster’s presentation is in Attachment XIV.

B. CLIC-ILC General Issues Working Group

The next report by this Working Group, noted Mike Harrison (Attachment XV), will be in January 2012, with a final report at the end of 2012. The Working Group has looked at siting technical issues, which mostly involve CLIC; vibration could rule out some sites, and cultural

noise could lead to a deep, laser-straight, site. Industrial procurement should use the experience gained by the LHC; ILC SCRF component numbers are larger than comparative LHC numbers. Quotes from the LHC experience include “single sourcing was either a success or a failure”, and use of the term “industrial jungle”---quality drift, strikes, bankruptcies, etc. WILL happen.

5. **PAC Summary and Recommendations**

Detectors

1. The PAC notes that ILD continues to keep many subsystem options. The Committee believes that this is not ideal, but understands the group's reasoning. Eventually a process will be needed to make choices among the options.
2. Both detector groups should show that their baseline detectors can achieve the goals of the benchmark processes.
3. The PAC notes and encourages the cooperation by the two detector collaborations with other detector R&D activities, both generic and specific to other colliders.
4. The PAC notes the concern expressed about the possible need for a power pulsing test.
5. The Committee is pleased at the adoption of a common push-pull system for the two experiments.
6. ILC-CLIC detector collaboration appears to be going well.

Accelerator

1. The PAC is pleased to learn of the additional emphasis on cavity field emission.
2. The current cavity tuner status is far from optimum, and the PAC would like to see one tuner design developed sufficiently to demonstrate its reliability.
3. The Committee is following with interest the developments on tumbling as a cavity conditioning method.
4. The Committee is impressed with the enormous effort at KEK and Fermilab to produce cavity strings that can be fully tested with beam. The Committee requests that a program of work be established post-2012 to maximize the information obtained from these facilities, in particular the long-term behavior under realistic fully loaded conditions so that the final design of the ILC can proceed with maximum operational experience.
5. The Committee strongly endorses the continuation of cavity development past 2012.
6. The PAC is interested to learn further on the need (or not) to have cavity location sorting.
7. ATF is congratulated on its recovery from the earthquake, and the Committee reiterates its opinion that ATF2 is a very valuable community resource.
8. The Committee agrees that the PPP approach to costing is the correct method to use for the TDR, but does note that there may be some exceptions for items where there is only a single supplier.
9. It should be noted that there is a cost to the host-lab coordination of multiple in-kind contribution of the same item.
10. The PAC supports the General Issues Working Group's current and proposed activities as presented to this PAC meeting

6. **Next PAC Meeting**

The next PAC meeting will be take place at Fermilab on 15/16 May 2012.

Appendix I

ILC Project Advisory Committee (PAC) Mandate

1. The International Linear Collider Steering Committee (ILCSC) is responsible for the oversight of the Global Design Effort (GDE) activities and of the ILC experimental program.

2. PAC will assist ILCSC in this function and report to the ILCSC.

3. PAC will review the GDE accelerator activities and, in addition, the ILC detector activities.

4. In its review activity, PAC will examine the overall consistency and realism of the project, in relation to physics, technical design, cost, and schedule.

5. PAC shall comprise about nine members, appointed by the ILCSC for terms of two or three years, and will meet a few times per year until the completion of the Technical Design Phases I and II.

6. The PAC Chair will be appointed by the ILCSC, normally for a two-year term.

Appendix II

PAC Review

Institute of Physics, Academy of Sciences of the Czech Republic, Prague
14/15 November 2011

Monday 14 November

08:30	Executive Session		(30)	
09:00	Welcome by ASCR			
09:30	Research Director's Report		(40+10)	S. Yamada
10:20	Break		(15)	
10:35	IDAG Report		(30+5)	M. Davier
11:10	Executive Session		(65)	
12:15	Lunch		(60)	
13:15	ILD		(30+5)	J. Timmermans
13:50	SiD		(30+5)	P. Burrows
14:25	MDI		(25+5)	K. Buesser
14:55	Break		(15)	
15:10	SCRF R&D incl. System Tests		(50+10)	M. Ross
16:10	Cavity Industrialization Planning		(25+10)	A. Yamamoto
16:45	GDE Director's Report		(30+10)	B. Barish
17:25	Executive Session		(85)	
18:50	Dinner			

Tuesday 15 November

08:30	ATF2		(30+5)	T. Tauchi
09:05	Project Implementation Planning		(25+5)	E. Paterson
09:35	TDR Plans and Scope		(25+10)	N. Walker
10:10	Break		(15)	
10:25	Costing	a) Accelerator	(20+5)	G. Dugan
		b) Detectors	(20+5)	S. Yamada
11:15	Collaboration with CLIC	a) Detectors	(20+5)	J. Fuster
		b) General Issues Group	(20+5)	M. Harrison
12:05	Lunch		(60)	
13:05	Executive Session		(70)	
14:15	Closeout			
15:00	End			

Appendix III

The Attachments, including the presentations made to the PAC, are available at
http://www.fnal.gov/directorate/ILCPAC/Nov2011/Attachments.html